



[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. FAA-2013-0723; Special Conditions No. 25-511-SC]

Special Conditions: Boeing Model 777-200, -300, and -300ER Series Airplanes;

Rechargeable Lithium Ion Batteries and Battery Systems

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions.

SUMMARY: These special conditions are issued for the Boeing Model 777-200, -300, and -300ER series airplanes. These airplanes as modified by the ARINC Aerospace Company will have a novel or unusual design feature, specifically the installation of rechargeable lithium ion batteries and battery system that will be used on an International Communications Group (ICG) ePhone cordless cabin handset. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

EFFECTIVE DATE: [Insert date 30 days after Federal Register publication].

FOR FURTHER INFORMATION CONTACT: Nazih Khaouly, FAA, Airplane and Flight Crew Interface Branch, ANM-111, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue SW, Renton, Washington, 98057-3356; telephone 425-227-2432; facsimile 425-227-1149.

SUPPLEMENTARY INFORMATION:

Background

On August 10, 2012, the ARINC Aerospace Company applied for a supplemental type certificate for installing equipment that uses rechargeable lithium ion batteries and battery systems in the Boeing Model 777-200, -300, and -300ER series airplanes. The Model 777-200 series airplanes are long-range, wide-body, twin-engine jet airplanes with a maximum capacity of 440 passengers. The Boeing Model 777-300 and 777-300ER series airplanes have a maximum capacity of 550 passengers. The Model 777-200, -300, and -300ER series airplanes have fly-by-wire controls, fully software-configurable avionics, and fiber-optic avionics networks.

Existing airworthiness regulations did not anticipate the use of lithium ion batteries and battery systems on aircraft. Lithium ion batteries and battery systems have new hazards that were not contemplated when the existing regulations were promulgated. In Title 14, Code of Federal Regulations (14 CFR) 25.1353, the FAA provided an airworthiness standard for lead acid batteries and nickel cadmium batteries. These special conditions provide an equivalent level of safety as that of the existing regulation.

Type Certification Basis

Under the provisions of 14 CFR 21.101, the ARINC Aerospace Company must show that the Boeing Model 777-200, -300, and -300ER series airplanes, as changed, continue to meet the applicable provisions of the regulations incorporated by reference in Type Certificate No. T00001SE or the applicable regulations in effect on the date of application for the change. The regulations incorporated by reference in the type certificate are commonly referred to as the “original type certification basis.” The regulations incorporated by reference in Type Certificate No. T00001SE are as follows: part 25, as amended by Amendments 25-1 through 25-82, except

for § 25.571(e)(1), which remains at Amendment 25-71 level. In addition, the certification basis includes special conditions and exemptions that are not relevant to these special conditions.

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 25) do not contain adequate or appropriate safety standards for the Boeing Model 777-200, -300, and -300ER series airplanes because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

Special conditions are initially applicable to the model for which they are issued. Should the applicant apply for a supplemental type certificate to modify any other model included on the same type certificate to incorporate the same or similar novel or unusual design feature, the special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, the Boeing Model 777-200, -300, and -300ER series airplanes must comply with the fuel-vent and exhaust-emission requirements of 14 CFR part 34, and the noise-certification requirements of 14 CFR part 36.

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type certification basis under § 21.101.

Novel or Unusual Design Features

The Boeing Model 777-200, -300, and -300ER series airplanes will incorporate the following novel or unusual design features: an International Communications Group (ICG) ePhone cordless cabin handset that will use a rechargeable lithium ion battery and battery system. Lithium ion batteries and battery systems have certain failure, operational, and maintenance characteristics that differ significantly from those of the nickel cadmium and lead acid rechargeable batteries. Rechargeable lithium ion batteries and battery systems are

considered to be a novel or unusual design feature in transport category airplanes, with respect to the requirements in § 25.1353.

Discussion

The current regulations governing installation of batteries in large transport category airplanes were derived from Civil Air Regulations (CAR) part 4b.625(d) as part of the recodification of CAR 4b that established 14 CFR part 25 in February 1965. The new battery requirements, § 25.1353(c)(1) through (c)(4), basically reworded the CAR requirements.

Increased use of nickel cadmium batteries in small airplanes resulted in increased incidents of battery fires and failures which led to additional rulemaking affecting large transport category airplanes as well as small airplanes. On September 1, 1977 and March 1, 1978, respectively, the FAA issued § 25.1353(c)(5) and (c)(6), governing nickel cadmium battery installations on large transport-category airplanes.

The proposed use of lithium ion batteries and battery systems for equipment and systems on the Boeing Model 777-200, -300, and -300ER series airplanes has prompted the FAA to review the adequacy of these existing regulations. Our review indicates that the existing regulations do not adequately address several failure, operational, and maintenance characteristics of lithium ion batteries and battery systems that could affect the safety and reliability of the airplanes with the ICG ePhone cordless cabin handset lithium ion battery installations.

At present, there is limited experience with use of rechargeable lithium ion batteries and battery systems in applications involving commercial aviation. However, other users of this technology, ranging from wireless telephone manufacturers to the electric vehicle industry, have

noted safety problems with lithium ion batteries and battery systems. These problems include overcharging, over-discharging, and flammability of cell components.

1. Overcharging

In general, lithium ion batteries and battery systems are significantly more susceptible to internal failures that can result in self-sustaining increases in temperature and pressure (i.e., thermal runaway) than their nickel cadmium or lead acid counterparts. This condition is especially true for overcharging, which causes heating and destabilization of the components of the cell, leading to the formation (by plating) of highly unstable metallic lithium. The metallic lithium can ignite, resulting in a self-sustaining fire or explosion. Finally, the severity of thermal runaway due to overcharging increases with increasing battery capacity due to the higher amount of electrolyte in large batteries.

2. Over-Discharging

Discharge of some types of lithium ion batteries and battery systems beyond a certain voltage (typically 2.4 volts) can cause corrosion of the electrodes of the cell, resulting in loss of battery capacity that cannot be reversed by recharging. This loss of capacity may not be detected by the simple voltage measurements commonly available to flightcrews as a means of checking battery status—a problem shared with nickel cadmium batteries.

3. Flammability of Cell Components

Unlike nickel cadmium and lead acid batteries, some types of lithium batteries and battery systems use liquid electrolytes that are flammable. The electrolyte can serve as a source of fuel for an external fire, if there is a breach of the battery container.

These problems experienced by users of lithium ion batteries and battery systems raise concern about the use of these batteries in commercial aviation. The intent of the special

conditions is to establish appropriate airworthiness standards for lithium ion battery installations in the Boeing 777-200, -300, and -300ER series airplanes and to ensure, as required by §§ 25.1309 and 25.601, that these lithium ion batteries and battery systems are not hazardous or unreliable. To address these concerns, these special conditions adopt the following requirements:

- Those sections of 14 CFR 25.1353 that are applicable to lithium ion batteries.
- The flammable fluid fire protection requirements of 14 CFR 25.863. In the past, this rule was not applied to batteries of transport category airplanes, since the electrolytes used in lead-acid and nickel-cadmium batteries are not flammable.
- New requirements to address the hazards of overcharging and over-discharging that are unique to lithium ion batteries.
- New maintenance requirements to ensure that batteries used as spares are maintained in an appropriate state of charge.

These special conditions are similar to lithium-ion batteries and battery systems special conditions adopted for the Boeing Model 787 (72 FR 57842; October 11, 2007).

Discussion of Comments

Notice of proposed special conditions no. 25-13-03-SC, for the Boeing Model 777-200, -300, and -300ER series airplanes, was published in the *Federal Register* on August 22, 2013 (78 FR 52107). No comments were received, and the special conditions are adopted as proposed.

Applicability

As discussed above, these special conditions are applicable to the Boeing Model 777-200, -300, and -300ER series airplanes. Should the ARINC Aerospace Company apply at a later date for a supplemental type certificate to modify any other model included on Type Certificate No.

T00001SE to incorporate the same novel or unusual design feature, the special conditions would apply to that model as well.

Conclusion

This action affects only certain novel or unusual design features on one model series of airplanes. It is not a rule of general applicability, and it affects only the applicant who applied to the FAA for approval of these features on the airplane.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The authority citation for these special conditions is as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, 44704.

The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for Boeing Model 777-200, -300, and -300ER series airplanes modified by the ARINC Aerospace Company.

These special conditions require that (1) all characteristics of the rechargeable lithium ion batteries and battery systems and their installation that could affect safe operation of the Boeing Model 777-200, -300, and -300ER series airplanes are addressed, and (2) appropriate instructions for continued airworthiness, which include maintenance requirements, are established to ensure the availability of electrical power from the batteries when needed.

In lieu of the requirements of 14 CFR 25.1353(b)(1) through (b)(4) at Amendment 25-113, the following special conditions apply. Rechargeable lithium ion batteries and battery systems on Boeing Model 777-200, -300, and -300ER series airplanes must be designed and installed as follows:

(1) Safe cell temperatures and pressures must be maintained during any foreseeable charging or discharging condition and during any failure of the charging or battery monitoring system not shown to be extremely remote. The lithium ion batteries and battery systems must preclude explosion in the event of those failures.

(2) Design of the lithium ion batteries and battery systems must preclude the occurrence of self-sustaining, uncontrolled increases in temperature or pressure.

(3) No explosive or toxic gases emitted by any lithium ion batteries and battery systems in normal operation, or as the result of any failure of the battery charging system, monitoring system, or battery installation that is not shown to be extremely remote, may accumulate in hazardous quantities within the airplane.

(4) Installations of lithium ion batteries and battery systems must meet the requirements of § 25.863(a) through (d).

(5) No corrosive fluids or gases that may escape from any lithium ion batteries and battery systems may damage surrounding structure or any adjacent systems, equipment, or electrical wiring of the airplane in such a way as to cause a major or more severe failure condition, in accordance with § 25.1309 (b) and applicable regulatory guidance.

(6) Each lithium ion battery and battery system must have provisions to prevent any hazardous effect on structure or essential systems caused by the maximum amount of heat the battery can generate during a short circuit of the battery or of its individual cells.

(7) Lithium ion batteries and battery systems must have a system to control the charging rate of the battery automatically, so as to prevent battery overheating or overcharging, and:

(i) A battery temperature sensing and over-temperature warning system with a means for automatically disconnecting the battery from its charging source in the event of an over-temperature condition, or,

(ii) A battery failure sensing and warning system with a means for automatically disconnecting the battery from its charging source in the event of battery failure.

(8) Any lithium ion battery and battery system whose function is required for safe operation of the airplane must incorporate a monitoring and warning feature that will provide an indication to the appropriate flight crewmembers whenever the state-of-charge of the batteries has fallen below levels considered acceptable for dispatch of the airplane.

(9) The instructions for continued airworthiness required by § 25.1529 must contain maintenance requirements to assure that the lithium ion batteries are sufficiently charged at appropriate intervals specified by the battery manufacturer and the equipment manufacturer. The instructions for continued airworthiness must also contain procedures for the maintenance of batteries in spares storage to prevent the replacement of batteries with batteries that have experienced degraded charge retention ability or other damage due to prolonged storage at a low state of charge. Replacement batteries must be of the same manufacturer and part number as approved by the FAA. Precautions should be included in the instructions for continued airworthiness maintenance instructions to prevent mishandling of the rechargeable lithium ion batteries and battery systems, which could result in short-circuit or other unintentional impact damage caused by dropping or other destructive means.

Note 1: The term “sufficiently charged” means that the battery will retain enough of a charge, expressed in ampere-hours, to ensure that the battery cells will not be damaged. A battery cell may be damaged by lowering the charge below a point where there is a reduction in the

ability to charge and retain a full charge. This reduction would be greater than the reduction that may result from normal operational degradation.

Note 2: These special conditions are not intended to replace § 25.1353(b) at Amendment 25-113 in the certification basis of Boeing Model 777-200, -300, and -300ER series airplanes.

These special conditions apply only to rechargeable lithium ion batteries and battery systems and their installations. The requirements of § 25.1353(b) at Amendment 25-113 remain in effect for batteries and battery installations on Boeing Model 777-200, -300, and -300ER series airplanes that do not use rechargeable lithium ion batteries.

Issued in Renton, Washington, on December 10, 2013.

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Acting Manager, Transport Airplane Directorate,
Aircraft Certification Service.

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